CLAIMS

1.

A torque transducer that includes:

first and second stage torsion bars connected in series,

said first stage torsion bar being characterized as having a higher torsional stress in torque transmitting operation than said second stage torsion bar, and

a torque sensor operatively coupled to said second stage torsion bar for measuring torque as a function of stress in said second stage torsion bar independent of said first stage torsion bar.

2.

The torque transducer of claim 1 further including a torsion overload shunt bridging said first and second stages for coupling the input of the first stage to the output of the second stage so that torque can be transmitted therebetween via said shunt in the event of a given differential torsional strain value being exceeded, such as occurs upon failure of either of said torsion bar stages.

3.

The torque transducer of claim 1 further including a failure sensor operatively coupled across the input of said first torsion bar stage and the input of said second torsion bar stage and operable to provide a sensor signal indicative of failure of either of said torsion bars.

4.

The torque transducer of claim 1 wherein said first and second stage torsion bars comprise a single integrally formed torsion bar, a first section of said torsion bar comprising said first stage having a lesser cross sectional dimension than a second section of said torsion bar forming said second stage.

5.

An automotive steering two-stage torque sensor system that includes:

An integrally formed torsion bar having first and second torsion bar sections respectively providing torsion bar first and second stages in series,

a first coupling for connection of the input of said first stage to a vehicle steering wheel,

a second coupling for connecting the output of said second stage through a steering shaft to a vehicle steering mechanism,

said first torsion bar section being constructed and arranged to have a higher torsional stress level in torque transmitting operation than that of said second torsion bar section and designed for providing a given steering feel at the steering wheel, and

a torque sensor operatively coupled to said second section torsion bar for measuring torque as a function of the stress/strain relationship in said second section torsion bar independent of the stress/strain relationship in said first section torsion bar.

6.

The torque sensor of claim 5 that further includes an overload shunt bridging said first and second stages for coupling the input of the first stage to the output of the second stage so that torque can be transmitted therebetween via said shunt in the event of failure of either of said torsion bar stages.

7.

The torque sensor of claim 5 further including a second sensor operatively coupled across the input of said first stage and the input of said second stage and operable to provide a sensor signal indicative of failure of either of said torsion bars.

8.

A method of rendering a torque transducer torque sensing system fail-safe comprising the steps of:

(a) providing first and second torsion bar stages connected in series,

(b) providing said first stage as one having a higher torsional stress level in torque transmitting operation than that of said second stage, and

(c) providing a torque sensor operatively coupled to said second stage for measuring torque as a function of stress in said second stage independent of said first stage.

9.

The method of claim 8 further including the step of providing a torsion overload shunt bridging said first and second stages for coupling the input of the first stage to the output of the second stage so that torque can be transmitted therebetween via said shunt in the event of failure of either of said torsion bar stages.

10.

The method of claim 8 further including the step of providing a second sensor operatively coupled across said first and second torsion bar stages such that said second sensor is operable to provide a sensor signal indicative of failure of either of said torsion bars.

11.

The method of claim 8 wherein said first and second torsion bar stages comprise a single integrally formed torsion bar, a first portion of said torsion bar comprising said first stage having a lesser cross sectional dimension than a second portion of said torsion bar forming said second stage.

12.

A method of rendering an automotive steering torque sensor system fail-safe comprising the steps of:

(a) providing an integrally formed torsion bar having first and second torsion bar stages connected in series,

(b) providing a first coupling for connecting the first stage input to a vehicle steering wheel,

(c) providing a second coupling for connecting the second stage output through a steering shaft to a vehicle steering mechanism,

(d) providing said first torsion bar stage as one having a higher torsional stress level in torque transmitting operation than that of said second torsion bar stage and designed for providing a given steering feel at the steering wheel,

(e) operatively coupling a torque sensor to said second torsion bar stage for measuring torque as a function of the stress/strain relationship in said second stage independent of such relationship in said first stage.

13.

The method of claim 12 further including the step of providing an overload shunt bridging said first and second stages for coupling the input of the first stage to the output of the second stage so that torque can be transmitted therebetween via said shunt in the event of failure of either of said torsion bar stages.

The method of claim 12 further including the step of providing a second sensor operatively coupled across the input of said first stage and the input of said second stage and operable to provide a sensor signal indicative of failure of either of said torsion bars.